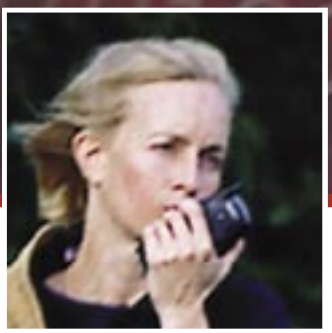
TOP PRIORITY:

A FIRE SERVICE GUIDE

To Interoperable Communications



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www.iafc.org

William Pessemier, Executive Communications Systems Advisor for the International Association of Fire Chiefs, is perhaps best known on the national level for his key incident command role for fire and emergency medical services during the Columbine High School tragedy. Chief Pessemier led the Littleton Fire Department team who made a presentation at a special evening session on the Columbine incident at the Fire Rescue International Conference in Kansas City immediately following the calamity. Overall communications, interoperability of radio systems between various agencies and incident command were key issues in the high school tragedy. Pessemier was appointed by the director of the Federal Emergency Management Agency to the America Burning Recommissioned panel.

Prior to becoming fire chief in Littleton in 1998, Pessemier was fire chief in Urbana, Illinois and assistant fire chief in Lynnwood, Washington. His career as a fire fighter began in 1979 in Kent and then later Bellevue, Washington.

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Introduction

The purpose of the handbook is to provide fire and emergency services with a comprehensive understanding of interoperability. This understanding, in turn, can form the foundation for increasing the effectiveness of emergency response services and improving the safety of emergency response personnel. Although written from a fire-service perspective, the handbook can be used by fire departments, emergency medical services, law enforcement agencies and emergency managers.

Information is powerful in its ability to change perspectives. This handbook can change the perspective of fire and emergency services regarding the importance and value of interoperability. It can also change the perspective of those who control local resources so that interoperability becomes a higher priority for local funding. If we are to realize the full potential of interoperability, fire and emergency services must decide to make interoperability a higher priority, and then establish an action plan to achieve it.

Public safety services cannot operate effectively without the ability to share information and resources with their disciplines and jurisdictions.

Many reports have been published supporting interoperability; unfortunately, most of them have been largely ignored. Interoperability is viewed by many as desirable but not essential. This view can no longer be supported. Although interoperability is a critical issue affecting the ability to deliver emergency services, it continues to be an elusive goal for most fire and emergency medical services organizations. Communications problems and the inability to coordinate with other disciplines and jurisdictions have been recognized as major operational limitations in every major incident, from the shootings at Columbine High School to the terrorist attack on the World Trade Center.

The 9/11 Commission Report is the latest in a long line of after-action reports that identified interoperability issues as a major factor limiting the effectiveness of emergency operations. Interoperability clearly impacts command and control, situational awareness and resource management. For example, the 9/11 Commission Report clearly stated that "command and control decisions were affected by the lack of knowledge." Further, "the means of transmitting information were unreliable" and "the ability to track which units were operating where was limited." In fact, "almost all aspects of communications continued to be problematic, from initial notification to tactical operations." Key decision makers "had almost no information about the situation" and "any attempt to establish a unified command on 9/11 would have been further frustrated by the lack of communication and coordination among responding agencies." Finally, "the Incident Command System did not function to integrate awareness among agencies or to facilitate interagency response."

These may appear to be harsh comments after the heroic efforts of the fire, law enforcement and medical personnel who responded to the attack, particularly considering the staggering number of deaths of public safety personnel. However, the lesson to learn is that these issues were a problem before the 9/11 attacks, and continue to be a problem today in most communities around the United States. Despite numerous after-action reports, public safety services have yet to make significant progress in comprehensively addressing interoperability.

Interoperability is important because it dramatically improves operational effectiveness and personnel safety. Whether an emergency response involves the fire and police departments from a single city, or the regional response of numerous fire, emergency medical and law enforcement personnel and equipment to a terrorist attack, the ability to establish a common operating picture, make rapid decisions and take effective action using a mix of public safety services can only be achieved through interoperability. Interoperability is essential to operability. Public safety services cannot operate effectively without the ability to share information and resources with other disciplines and jurisdictions.

This handbook provides a common operational definition of interoperability, discusses the foundation for interoperable communications, and provides direction to establish interoperability between and among public safety services, including fire, emergency medical and law enforcement organizations.

The Context of Interoperability

Strategic Perspectives

Interoperability addresses several important strategic issues. The process of planning and implementing operational and technical interoperability improvements has the potential to build relationships on a regional basis. Interoperability planning can bring people from various disciplines or jurisdictions together that otherwise may not know each other or who may not understand each other's operations. When people get to know each other better, and have a better understanding of what they do, they are more likely to be able to work together.

Interoperability improves regional response capability. This is true not only for special operations, but for day-to-day operations as well. The impact of interoperability on normal operations is arguably the most important and valuable reason for making the effort to improve operational and technical interoperability. Interoperability should be scalable to match the operational and tactical needs of the event. The systems and procedures that are used on a regular basis must be able to be scaled up to work with increasing levels of complexity as the need for interoperability between increasing numbers of response agencies and their respective resources. Emergency response personnel, from firefighters and police officers to command officers, must use interoperable systems and related equipment on a regular basis, during the daily routine of their work, so that they are familiar with the technical and operational capability of their equipment and can quickly and easily scale up to match their capability with the level of complexity of the incident.

Interoperability also has the potential to reduce unnecessary redundancy and to thereby reduce expenditures. A regional planning approach has the ability to reduce the need for additional equipment and expenditures to connect disparate communications systems. Regional planning may also reduce the number of additional radios that must be purchased in order for one jurisdiction to be able to talk to another.

Operational and Tactical Perspectives

The operational and technical aspects of interoperability provide a rational basis for assessing how public safety services can best accomplish their mission with available resources. Examining the status of operational interoperability (how disciplines and jurisdictions work together) provides the opportunity to make improvements in the effectiveness of joint operations and ultimately in your ability to provide emergency services for the public. Interoperability also maximizes resource management by increasing the effectiveness and efficiency of response resources. Both physical and information resources are used more effectively with higher levels of interoperability. In addition, the flexibility of operational resources is increased. Resources that have a high level of interoperability also have a high level of interchangeability, which increases operational flexibility and the capacity to respond to changing conditions over the course of an incident.

In addition to improvements in resource management, one of the most important operational improvements that results from interoperability is an increased level of situational awareness. A common operational picture of an incident is critical to operational planning and decision making. If firefighters have one picture of what is happening at an event, and law enforcement has a different picture of the same event, and the information cannot be exchanged between the two disciplines, then operational effectiveness will be reduced and personnel safety will be jeopardized.

Technological Perspectives

Technical capabilities and limitations of communications systems must be clearly described so that the capabilities and limitations of interoperability are recognized. This helps to establish realistic expectations of what technology can accomplish. In addition, a detailed description of technical systems provides the basis for establishing the linkages and interfaces between systems for the exchange of information. For example, after a review of communications systems between a fire department, police department, and a third service EMS provider, it may be determined that each has a separate system with no connections for allowing the exchange of voice or data information. However, all three services use cell phones. It may be possible to link the three services with a cellular service that provides an 800 MHz trunked radio system in addition to their regular cellular phone service, such as the Nextel Radio Service capability. In addition, technology makes it possible to integrate the Nextel Radio Service capability with each of the various radio systems used by these disciplines through console integration equipment. This type of technology provides for technical and operational interoperability with very little if any additional expense, and also provides a supplemental or secondary communications system in the event that the primary LMR system fails. In addition, a technological solution such as this provides the ability to offload non-essential communications from the primary communications system onto the secondary system.

Interoperable Communications Defined

Interoperability is widely viewed as the solution to communications problems between and among public safety services. It has been narrowly defined as the ability of public safety services to talk to each other or to share data when necessary. While technological advances have made it possible to establish interoperability, it has not been achieved in most communities throughout the United States. Why? Because interoperability involves the ability to work together first, and the ability to talk to each other second.

Operational Interoperability

Operational interoperability is the ability to work together effectively. Specifically, it is the ability of different jurisdictions or disciplines to provide services to and accept services from other jurisdictions or disciplines, and to use those services to operate more effectively together at an emergency.

From a practical perspective, operational interoperability means that personnel from different jurisdictions or services perform as a team under a common command-and-control structure. To do this, they must be able to communicate horizontally with other response resources, and vertically with appropriate command staff. In the fire service, automatic and mutual aid agreements help to share response resources. Yet many jurisdictions do not operate effectively together because of isolated communications systems or differences in operational practices, or more subtle and difficult cultural issues, such as territorialism, competition, and an attitude of self-sufficiency.

These obstacles to operational interoperability have limited the extent to which the fire service has utilized advances in technical interoperability, thereby reducing the effectiveness of response resources and jeopardizing the safety of emergency response personnel. If public safety services are to achieve interoperability, the obstacles to operational interoperability must be made explicit so that they can be overcome.

SAFECOM defines interoperability as the ability of public safety and support providers—law enforcement, firefighters, EMS, emergency management, public utilities, transportation, health, medical and others—to exchange voice and data communications on demand, in real time and when authorized.

Technical Interoperability

Technical interoperability is the ability to communicate and exchange information. More formally, it can be defined as the ability of systems to provide dynamic interactive information and data exchange among command, control and communications elements for planning, coordinating, integrating and executing response operations. The most common systems used by public safety services involve voice and data information exchange, which is usually accomplished by Land Mobile Radio communications systems. Pagers, telephones and cellular phone systems are also commonly used to exchange information. Technical interoperability is essential for operational interoperability. Technical systems must be able to reliably allow exchanging essential voice and data information that is accurate, timely, relevant and operationally useful.

Principles of Interoperability

If interoperability is to be implemented between and among public safety services, a number of decision-making principles must be accepted. The guiding principles presented here provide the foundation to build operational and technical interoperable communications systems.

Operational Needs

Tactical-level operations between and among public safety services must be the starting point for examining what type and how much interoperability is required. The ability to deliver joint, flexible, coherent and coordinated operations between several different fire departments, or between a fire department, police department and emergency medical service, must be anticipated in terms of:

Public safety operations require effective command, control, communications and information sharing in order to mount well coordinated responses.

- Who responds to what type of incident?
- What is their tactical objective and task?
- Where do they fit into the command structure of the incident?
- What information-exchange requirements exist between different response resources and between response resources and command staff?
- How will these information exchanges be accomplished?

How units operate together determines the type and frequency of information exchanges and what technical systems are used to exchange voice and data information.

Regionalized Planning and Implementation

Because interoperability is all about the ability of different disciplines or jurisdictions to work together and talk to each other, interoperability planning begins by determining which disciplines and jurisdictions should be included in the planning process. Disciplines that work together on a daily or weekly basis should be clearly included in a regional interoperability planning group.

Once the planning group has been established, its members should examine public safety operations. Include a detailed description of current operational and technical interoperability levels, as well as the desired levels. The difference between the current and desired level of interoperability is the performance gap for operational and technical interoperability. This becomes the starting point for prioritizing issues.

The next phase is to make the best use of currently available resources. If additional funding is required to implement the improvements recommended by the planning group, local decision makers are more likely to support the joint recommendations of public safety services on a regional basis. Competitive grants are also rated higher when they include regions instead of single jurisdictions. In addition, the economies of scale available on a regional basis make regional programs more cost-effective. When the public is aware of efforts to improve the ability of public safety services to work together and talk to each other, it is easier to gain support for interoperability initiatives.

Leadership Commitment to Regional/Joint Operations Strategy

The leadership of every public safety service must support the need for operational and technical interoperability on a regional basis. Some may resist the idea of working together with other fire department or law enforcement agencies. The imperative to improve operational effectiveness and personnel safety must take precedence over the historical problems of territorialism and competition, and the myth of self-sufficiency. Develop a common voice to facilitate budget and policy decisions. In addition, find ways to reward interoperability, and provide sanctions for those who ignore it or stand in the way.

Look beyond your department for support. State and local government officials should be brought on board. Provide information so that government officials understand the importance of interoperability, and help them to communicate the benefits of interoperability to the public. Find out what political and institutional barriers within the community may impede interoperability, and facilitate collaborative planning among local, state and federal agencies.

Funding and Resources

A lack of resources or funding is the most common obstacle to improving the interoperability of communications systems. That is why state and federal agencies have developed numerous grant programs to assist in the area.

For information on grants, go to www.FedGrants.gov, www.ojp.usdoj.gov, www.firegrantsupport.com, www.cfda.gov, www.wifcon.com/todaysfa.htm, and www.Grants.gov. Grant workshops are available at conferences and regionally through specific DHS programs. The number one reason fire departments do not get grant funds is that they do not apply.

To improve your case for funding, look for partnerships to expand the system's impact. Reallocating resources within a department's budget is a practical and legitimate means of improving interoperability by funding technical and operational solutions. We can no longer afford to ignore interoperability, or to view it as a secondary budget item to be funded only if extra money becomes available. Interoperability is essential to effective emergency response operations in every community, and increases the safety and survival of every emergency responder.

Many of the capabilities and goals of interoperability can be realized through shifts in resources and changes in priorities and training rather than through acquiring new technology.

New technologies integrate systems so that the money you spend on many devices can be combined into one device. For example, an advantage to using Nextel handsets as a parallel system to a fire service communications system is the consolidation of equipment. The push-to-talk capability included in Nextel handsets can function as a secondary 800 megahertz (MHz) trunked radio system (radio functionality), send and receive messages (pager functionality), are GPS-enabled (Automatic Vehicle Location (AVL) functionality), and also function as a cellular phone (cellular functionality). The radio function of this commercial system can be integrated into almost any department's land mobile radio console, thus providing a highly functional secondary or parallel interoperable communication system at a relatively low cost.

The ability to consolidate functions into one device has the potential for significant cost savings, improved operational utility, and a more effective operation. Personnel in non-life-threatening positions can utilize devices with enhanced features at a fraction of the cost of a $3,000 portable radio with limited features. Rather than having to learn to operate several different devices, personnel only need to be trained on one device.

Accept the 80% Solution

Public safety organizations have high standards for personnel and equipment. In many cases, the ability to establish improved interoperability has been stalled because it has not been possible to identify a solution that meets the high standards of public safety. In some cases, it may be prudent to accept a solution that is less than ideal so that interoperability is improved in the short term. For example, if a solution can be found that increased interoperability from 40% to 80%, that is a 100% increase in capacity. The solution may not be perfect, but it represents a substantial improvement. Add to this increased capacity the fact that new technologies provide many other non-mission-critical features that enhance public safety operations, such as computer-aided dispatch (CAD) alerts to wireless devices, internet access, GPS and more. This increased capacity gives you a solution that is worth considering.

Leveraging Commercial Technology

The reluctance of many public safety services to use commercial systems may be based on the long history of private ownership of communications systems, and the need for redundancy and reliability. However, the reliability and redundancy of commercial systems has improved greatly, and can be further increased to meet the needs of public safety. Commercial providers have partnered with public safety services to accomplish this goal. For example, Sprint together with Nextel has worked with several public safety services to install back-up generators at cellular phone sites to improve the reliability of their communications system. These efforts can be further enhanced through public-private partnerships between vendors and local governments.

Commercial systems provide a relatively inexpensive and immediately available solution to technical interoperability problems. When working with commercial vendors, specific capabilities and requirements must be clearly identified, such as the requirement for reliability or the technical capability of a system to provide service. For example, specifications for a cellular phone service may include the requirement that the system not fail if the normal power system is rendered inoperable, and that the system provide service to at least 95% of the coverage area.

Challenges to Interoperability

Achieving optimum interoperable communications requires that organizations and agencies throughout the public sector overcome the many challenges that surround interoperability—cultural, technical and financial.

Cultural

Public safety services share boundaries and compete for resources with other public safety disciplines and jurisdictions. As with any network of organizations operating in this context, territorialism and competition can be expected. Public safety personnel have a great deal of pride in their departments and do not want to have to rely on others to fulfill their mission. They want to be self-sufficient and have the political, social and financial support necessary to provide the level of services that the public needs and expects. They may think that the need to rely on other jurisdictions or disciplines indicates a lack of community support or limited organizational capability.

Information management must become a first-line response function.

Although tremendous progress has been made to increase cooperation among emergency services, some personnel still resist working with other organizations and see such cooperation as a threat to their job security or pride in their department. Every emergency service organization has members who can still be heard to say things like, "This is our area. We don't need those guys coming in here. We can take care of our own area." Although the concern for job security may be legitimate, allowing these concerns to limit the ability to provide effective emergency services is not acceptable. An attitude of territorialism, competition and self-sufficiency not only limits the ability to provide emergency services, but also unnecessarily places emergency responders and the public at risk.

Departments may wait too long to call for help at emergencies because they think they can handle the event on their own. Delays in resource acquisition and deployment seriously limit operational effectiveness, and put response personnel at risk. For example, the ability to sustain interior attack lines or deploy rapid intervention teams may depend on early requests for additional resources. If departments continue to use territorialism, competition and self-sufficiency as excuses to avoid working together in a more planned, coherent and coordinated manner, the public will eventually withdraw support for emergency services. Recent town hall meetings conducted by the Council on Excellence in Government clearly showed that the public wants and expects their public safety services to be able to work together in the best interests of the community they serve. To accomplish this goal, operational interoperability must be an essential factor in service delivery and personnel safety. Only after operational interoperability is accepted and fully supported by emergency services will we be able to implement and sustain solutions to the problem of technical interoperability.

Technological

It is not uncommon for the fire service to do something because "we have always done it that way." As a whole, the fire service has used little currently available technology. The fire service may find it difficult to think of ways to use new technology, or we may not see the need or feel the sense of urgency necessary to drive improvements in interoperability.

Innovation and experimentation must become an inherent function of emergency service organizations. Every public safety service has one or more individuals who are fascinated by technology and capable of finding new ways to make it work to improve services and increase the safety of personnel. The fire service as a whole can learn from the experiments and innovation of other fire departments as well as other disciplines, such as law enforcement Department of Defense, private industries and mining operations. Innovation and experimentation must be supported with research and development resources, and through encouragement and leadership of staff officers. It should be understood that innovation and experimentation sometimes leads to failures, and that those failures can provide tremendous insight into other workable solutions.

Ideally, this handbook will create a greater awareness about the potential of interoperability to improve service delivery and increase personnel safety. The perspective and context presented here can create the foundation of greater innovation and experimentation using the technology that will be discussed in the section on technical systems. First responders are pragmatic and practical when given the resources and support necessary to find solutions to problems. To make the best use of current and future technology, we must be able to support creative and innovative solutions to interoperability problems and think outside of our usual comfort zone.

Many of public safety's current communications and information systems are outdated. These legacy systems present a serious obstacle to technical interoperability. The sunk costs of these systems represent a major financial limitation; replacing them with

modern systems is usually expensive. The short-term solution is to make the best use of current available systems, enhance communications with commercial off-the-shelf equipment, and develop a regional plan to replace or upgrade legacy systems. Given the speed at which technology changes, it may be practical to develop a relatively short-range plan, extending out no more than three to five years.

Do not use the existence of legacy systems as an excuse for not implementing interoperable communications. When purchased and used regionally, much commercial off-the-shelf equipment can greatly enhance the effectiveness of public safety communications at relatively low cost. The cost-effectiveness and operational impact of regional interoperability planning has the highest potential to overcome many of the limitations of legacy systems.

Most public safety communications systems are like stovepipes—individual systems that are fragmented and do not communicate with one another to facilitate operational interoperability.

Financial

The common refrain heard when most emergency services talk about interoperability is, "We can't afford it." Yet almost every operation involving the fire service, and other emergency services, requires some level of interoperability. A house fire requires the response of the police to control traffic, public utilities to shut off power and gas, other jurisdictions to provide on-scene help or coverage, emergency medical services to treat and transport the injured, and the Salvation Army or Red Cross to provide support services. Interoperability is essential to our ability to provide effective emergency response services. Therefore, issues of operational and technical interoperability should receive a level of support commensurate with its priority as an essential element of emergency service.

Interoperability is not a new issue for emergency service organizations. Yet we talk about it as if it were an unfunded mandate that has suddenly appeared. Several issues have created this situation. In some cases, the continued decline in support and funding for emergency services has forced more operational interoperability to sustain service levels. On a national scale, the essential nature of interoperability is more apparent as a result of terrorist attacks requiring unanticipated levels of cooperation and coordination. We now recognize that a lack of interoperability limits the effectiveness of these operations and jeopardizes the safety and survival of emergency responders. Interoperability should not be viewed as something we would like to have if we only had the money. Operational and technical interoperability are essential to emergency response services, and should be given the same priority in terms of resources. The federal government supports developing interoperable communications by including this effort in numerous grant programs. Given previous catastrophic events, public safety planners must understand the cost, impact and liability of not being able to achieve interoperable communications.

Impact of Limited Interoperability

Limited interoperability reduces the ability of emergency services to accomplish our mission, increases the risk to emergency responders, and creates the perception that some organizations are more interested in protectionism than professionalism.

More specifically, limited interoperability decreases the effectiveness of resources and limits the ability to form a common operational view of the incident. Compared to resources deployed under operational and technical interoperability, resources deployed with limited interoperability have the following limitations:

- Decreased ability to coordinate operational tasks with other jurisdictions or disciplines at a peer-to-peer level while responding to and operating at the scene of an emergency.
- Decreased ability to coordinate operations with commanders and make decisions in the field.
- Emergency response personnel must resort to ad-hoc workarounds to accomplish operational tasks in cooperation with other jurisdictions or disciplines. This situation can lead to increased freelancing, which jeopardizes personnel safety and reduces the ability to maintain operational command and control.
- Delays in completing tactical objectives and tasks owing to unfamiliarity with the operations and procedures of other disciplines and jurisdictions or the inability to communicate during integrated operations.
- The reaction or cycle time required to complete assigned tactical objectives is increased owing to delays in communication between commanders and resources.

- Commanders take longer to make decisions and are less confident in the incident action plan owing to incomplete, inaccurate, conflicting and ambiguous information.
- Different disciplines or jurisdictions operating at the scene of an emergency are not able to share mission-critical information about the incident owing to intermittent or missing communications links.

The fire service must put aside concerns about protecting turf, and refocus efforts on protecting the public and personnel. Fire and emergency service professionals, whether volunteer or paid, have a responsibility to the public and to ourselves to work together to provide the best service to the public while protecting the safety of our people. Building interoperability can accomplish both of these goals.

Exchanging information through communication systems is critical to decision making and safety.

Impact of Improved Interoperability

Interoperability improves the effectiveness of resource management through the command structure of the incident. Communications systems allow information to be exchanged, thereby establishing a common operational picture of an incident. Command, control and communications are the means through which resource management is made more effective and situational awareness is increased. The operational impact of better command, control and communications, or increased operational and technical interoperability, includes the following:

- Makes a smaller force more effective by leveraging assets.
- Provides for faster planning and execution; better and faster decisions.
- Resources become more effective through better peer-to-peer coordination, which facilitates flexible and autonomous action.
- Minimizes ad-hoc workarounds and freelancing.
- More rapid, coherent and coordinated operations.
- Increases situational awareness through a common operational picture.
- More effective resource management through more effective command and control.

Measuring Interoperability

Measuring interoperability is difficult because it crosses so many technical and operational issues. Some form of measurement criteria must be established for emergency services to develop goals and measure progress. Because objective and quantitative measures of interoperability are difficult to define, it is necessary to use qualitative, subjective and implied judgments about how well a department is doing.

The interoperability planning matrix presented in Figure 1 provides a method of assessing interoperability. Measures of operational interoperability include the criteria listed in the section on incident management, resource management, and situational awareness. Measures of technical interoperability include the criteria listed in the section on individual communications systems and interoperability of individual communications systems.

Operational Interoperability

Operational Criteria (OC) for evaluating ICS include:

OC1: Whether the command and control structure/organization is based on National Incident Management System (NIMS)

OC2: The extent to which the command and control structure is appropriate for a given incident.

OC3: The degree to which command and control is integrated or unified with other emergency response services.

Operational Criteria (OC) for evaluating resource management include:

OC4: Planning (integrated operations or coordinated partitioning).

OC5: Information acquisition, assessment, course of action development, decision-making, direction of resources.

OC6: Clarity of direction.

OC7: Progress and situational reports.

OC8: Cycle time of operations; task assigned, initiation, completion, report.

Operational Criteria (OC) for evaluating situational awareness include:

OC9: Percentage of response resources, command staff, agencies involved in response that share a single, integrated operational picture of the incident.

OC10: Ability to share information about changes in the incident in a timely manner.

OC11: Ability to distribute critical information to response resources.

See Figure 1 for an example of an interoperability planning worksheet.

Figure 1: Interoperability Systems Planning Matrix

	Single Jurisdiction	**Multiple Jurisdiction**
Single Discipline	Operational Interoperability OC1 – OC11 Technical Interoperability TC1 – TC15	Operational Interoperability OC1 – OC11 Technical Interoperability TC1 – TC15
Multiple Discipline	Operational Interoperability OC1 – OC11 Technical Interoperability TC1 – TC15	Operational Interoperability OC1 – OC11 Technical Interoperability TC1 – TC15

SAFECOM is a federal entity that was established to help local, tribal, state, and federal public safety agencies improve public safety response through more effective and efficient interoperable wireless communications. SAFECOM is the first national program designed by public safety for public safety. As a **public safety practitioner driven program**, SAFECOM is working with existing federal communications initiatives and key public safety stakeholders to address the need to develop better technologies and processes for the cross-jurisdictional and cross-disciplinary coordination of existing systems and future networks. SAFECOM harnesses diverse federal resources in service of the public safety community. The scope of this community is broad. The customer base includes over 50,000 local and state public safety agencies and organizations. Federal customers include over 100 agencies engaged in public safety disciplines such as law enforcement, firefighting, public health and disaster recovery. SAFECOM makes it possible for the public safety community to leverage resources by promoting coordination and cooperation across all levels of government. For more information on SAFECOM go to www.safecomprogram.gov or call 1-866-969-SAFE.

SAFECOM has developed a tool that can be used to measure and compare core facets of interoperability along a continuum of five critical issues. These include frequency of use, governance, standard operating procedures, technology, training and exercises (*see Figure 2*). The interoperability continuum provides a means of comparing the current state of interoperability elements with the future desired state.

An assessment of these criteria can be used as a baseline for evaluating the level of overall interoperability and planning. Operational interoperability should measure the degree to which response resources can be shared between jurisdictions and disciplines, and how effectively these resources are able to work together in joint response operations. Technical interoperability should measure the ability to exchange information (voice and data) between response resources and among command and control elements of the operation. Once the level of interoperability has been evaluated, planning should begin by prioritizing which systems are most important to operational effectiveness and personnel safety. These are the systems that should receive the most attention initially.

Figure 2: Interoperability Continuum

	Limited Leadership, Planning and Collaboration Among Areas					High Degree of Leadership Planning and Collaboration Among Areas
Frequency of Use	Planned Events	Localized Emergency Incidents		Regional Incident Management	Daily Use Throughout Region	
Governance	Individual Agencies Working Independently	Informal Coordination Between Agencies		Key Multidiscipline Staff Collaboration on a Regular Basis	Regional Committee Working with a Statewide Interoperability Committee	
Standard Operating Procedures	Individual Agency SOPs	Joint SOPs for Planned Events	Joint SOPs for Emergencies	Regional Set of Communications SOPs	National Incident Management System Integrated SOPs	
Technology	Swap Radios	Shared Channels	Gateway	Proprietary Shared Systems	Standards-based Shared Systems	
Training & Exercises	General Orientation on Equipment	Single Agency Tabletop Exercises for Key Field and Support Staff	Multiagency Tabletop Exercises for Key Field and Support Staff	Multiagency Full Functional Exercise Involving All Staff	Regular Comprehensive Regional Training and Exercises	

Minimal Level ← **Interoperability Continuum** → **Optimal Level**

Technical Interoperability

Individual Communications System Performance
Technical Criteria (TC) for grading scale for individual communications systems include:

TC1: Coverage.

TC2: Capacity/channel loading.

TC3: Reliability.

TC4: Redundancy.

TC5: Training.

TC6: Standard operating procedures.

See Figure 3 for an example of a performance evaluation worksheet.

Figure 3: Individual Communications Systems Evaluation Matrix

Fire Communications System (System 1)	TC1 – TC6
Police Communications System (System 2)	TC1 – TC6
EMS Communications System (System 3)	TC1 – TC6
Hospital Communications System (System 4)	TC1 – TC6
Public Works Communications System (System 5)	TC1 – TC6
EOC Communications System (System 6)	TC1 – TC6

Interoperability of Individual Communications Systems
Criteria for grading scale for the interoperability of communications systems include:

TC7: Operational planning; information/capabilities/service exchange requirements.

TC8: Technical planning; compliance with established rules and guidelines for interoperability.

TC9: Systems planning; interface points and connections between systems.

TC10: Training.

TC11: Standard operating procedures.

TC12: Pre-established radio nets, frequency assignments, talk groups (command, tactical, support, EMS, law enforcement, public works).

TC13: Capacity/scalability.

TC14: Redundancy.

TC15: Extent of interoperability; local, regional, state, federal.

See Figure 4 for an example of performance evaluation worksheet.

Figure 4: Communications Interoperability Evaluation Matrix

	System 2	**System 3**	**System 4**	**System 5**	**System 6**
System 1	TC7 – TC15	TC7 – TC15	TC7 – TC15	TC7 – TC15	TC7 – TC15
	System 2	TC7 – TC15	TC7 – TC15	TC7 – TC15	TC7 – TC15
		System 3	TC7 – TC15	TC7 – TC15	TC7 – TC15
			System 4	TC7 – TC15	TC7 – TC15
				System 5	TC7 – TC15

Training and Evaluation

If an interoperability systems plan is adopted and published, but then sits on the shelf in the office, it is useless. Make a plan come to life by practicing the operational procedures established in the plan. Training based on the doctrine of operational interoperability increases the confidence and competence of the participating members, particularly in the members of other organizations.

Training programs are necessary to evaluate, support and improve operational and technical interoperability, especially those involving multiple disciples or jurisdictions. Training should support operational needs, methods and procedures, as well as a regional approach to interoperability. When multiple jurisdictions and disciplines are required to work together but have not trained together, the result is confusion, operational conflict, limited situational awareness, decision making based on limited information, and uncoordinated resource management. When multiple jurisdictions and disciplines train together, the result is a coordinated and effective operation and a higher level of personnel safety.

Frequent and realistic joint exercises are necessary to identify interoperability shortfalls and obstacles to interoperability that would otherwise remain hidden.

Evaluations, after-action reports, and critiques of training sessions or actual operations have a history of being less than completely honest about the shortcomings of systems, procedures, decisions, and actions of crews and individual personnel. Training and evaluation must be frequent, realistic, and objective to provide constructive criticism. Training tests the ability of public safety services to work together and exchange information across a wide variety of operational scenarios. After each training session, be explicit about specific issues relating to operational and technical interoperability to foster improvements.

Joint training provides the best opportunity for experimentation and innovation. Training exercises can also be used to help develop key performance parameters for tactical operations. These parameters are based on the mission-essential tasks, such as search and rescue, getting water on the fire, ventilation, forcible entry, and water supply. Use the parameters to measure the performance of the mission-essential tasks, which in turn help you gauge the effect of interoperability. For example, the performance of the mission-essential tasks of search and rescue for a three-story apartment building might be measured by the following parameters:

1. Time from dispatch of units to completion of primary search.
2. Time from dispatch of units to completion of secondary search.

The key performance parameters for the mission-essential task of search and rescue in a three-story apartment building can then be measured during operations without interoperability and compared to operations with interoperability. The time required to complete the primary and secondary search is substantially longer when units are unable to share information and effectively manage response resources.

Operational interoperability training should be dynamic, capabilities-based and constructive. By working together, jurisdictions and disciplines can respond to changing conditions and unpredictable events. The ability to adapt and respond quickly to such changes is an essential component of operational readiness. Joint training identifies the capabilities required by jurisdictions and disciplines to effectively respond to emergencies. Develop regional joint training exercises, or utilize commercial training exercises that support interoperable communications.

Constructively but critically evaluate training exercises. Objectively describe and analyze the course of action taken during the training, and systematically measure the performance of each crew and individual to improve operational effectiveness. Questions that should be answered include:

- What did we have?
- Who was there?
- What did we do?
- How effective were we?
- How can we improve?

It is critically important not to distort the answers to these questions just to keep feelings from being hurt. We often don't want to say anything critical of our fellow public safety professionals, but the ability to improve our operational capabilities depends on honestly assessing capabilities, practices and performance.

Emergency Management

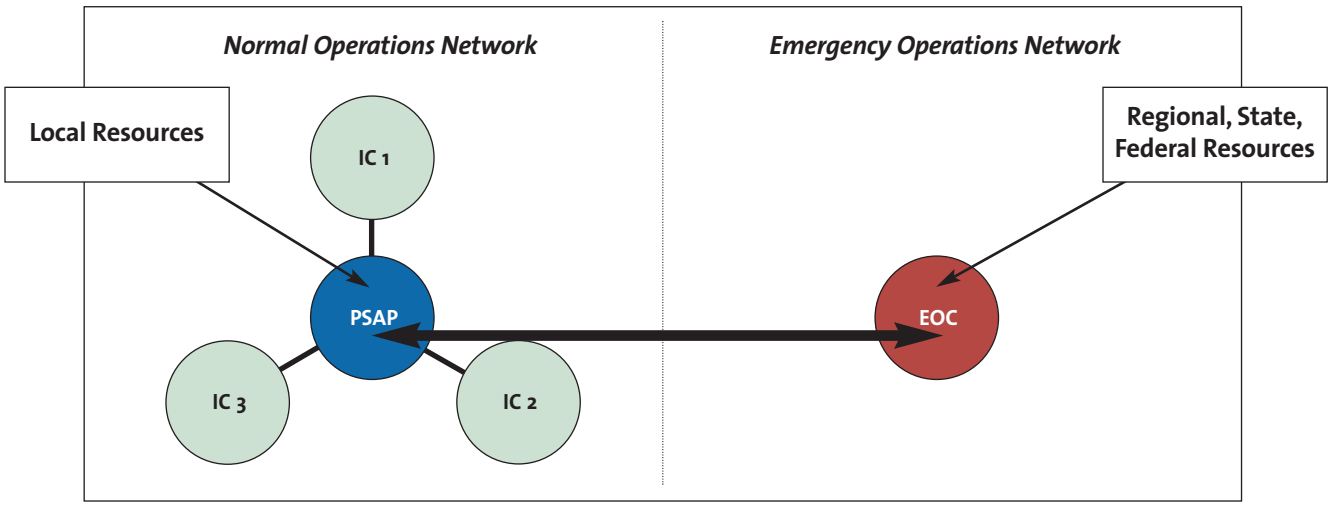
When an Emergency Operations Center (EOC) is activated, two of the primary roles of emergency management are to manage resources responding from outside the local area, and to develop a comprehensive awareness of the emergency situation. Resource management and situational awareness are two critical capabilities for an EOC. These capabilities are identical to those required for normal operations, only on a larger scale. Just as communications nets are required to manage resources and maintain situational awareness during the course of normal, day-to-day operations, such networks are critical for the effective management of large scale emergencies requiring the activation of the local EOC.

After the initial activation of an EOC, resources at the local level are managed by the Public Safety Answering Point (PSAP). Depending on the nature and extent of the emergency, regional, state and federal resources are usually managed through the EOC (see Figure 5). As resources respond to the event, they must know how to contact the EOC in order to receive direction and information. Resources must be assigned to base or staging areas or may be assigned directly to incident operations.

The local PSAP must have the ability to communicate with the EOC in order to coordinate resource management and to exchange information about the event in order to maintain a common operational picture of what is happening. In fact, the EOC may need to coordinate and communicate with multiple PSAP's or communications centers, such as separate fire, law enforcement and emergency medical services. As local resources are assigned to emergencies, it may become necessary for the PSAP to request additional resources from the EOC, either for the emergency operation or normal operations. When local resources are assigned to the emergency operation (which required the activation of the EOC), other resources may need to be assigned to cover for response to the normal emergencies that are occurring outside of the emergency operation. These resources will normally be requested through the EOC, which will require a communications net or system that can operate if the radio and public telephone system are overloaded and inoperative.

The Communications Interoperability Evaluation Matrix can be used to evaluate the current level of interoperability between PSAP's, the EOC, and the local, regional, state, and federal resources that would be expected to respond to an emergency requiring the activation of the EOC. It may be desirable to establish pre-determined communications nets for normal operations and for emergency operations. This will allow for the coordination of regional, state and federal resources through the EOC, and the transfer of resources from the EOC to the appropriate local PSAP when necessary.

Figure 5: EOC Activation



As a major emergency continues to develop, it may become necessary to transfer the management of one or more incidents from the PSAP to the EOC (see Figure 6). Most PSAP's or public safety communications centers are staffed to deal with normal, day-to-day operations. Although every communications center has the capacity to deal with an increased work load, major catastrophic events are likely to overload the local communications center, which is one reason for activation of the EOC. At some point, it may be necessary and prudent to transfer the incidents involved in the major or catastrophic emergency (which precipitated the activation of the EOC) over to be managed by the EOC staff.

This may involve just one major event, such as a terrorist attack on a public facility, where one incident commander or unified command is communicating with the EOC. In other scenarios, several incidents commanders may be involved in the same emergency, such as in the case of a winter storm that has been geographically divided into several commands. In either case, at some point when the emergency has overwhelmed the capacity of the local PSAP, the EOC must have the capability to assist by managing the resources necessary to effectively respond to the emergency. Again, this will require the development and implementation of a pre-determined communications net so that resources assigned to a command are assigned to the same channel, frequency or communications system, which can be accomplished by establishing communications nets based on functional or mission elements (see Figures 8 and 9). The final state of the communications networks required to coordinate normal operations and emergency operations would be represented by Figure 7.

Figure 6: Transfer of Incident Management to EOC

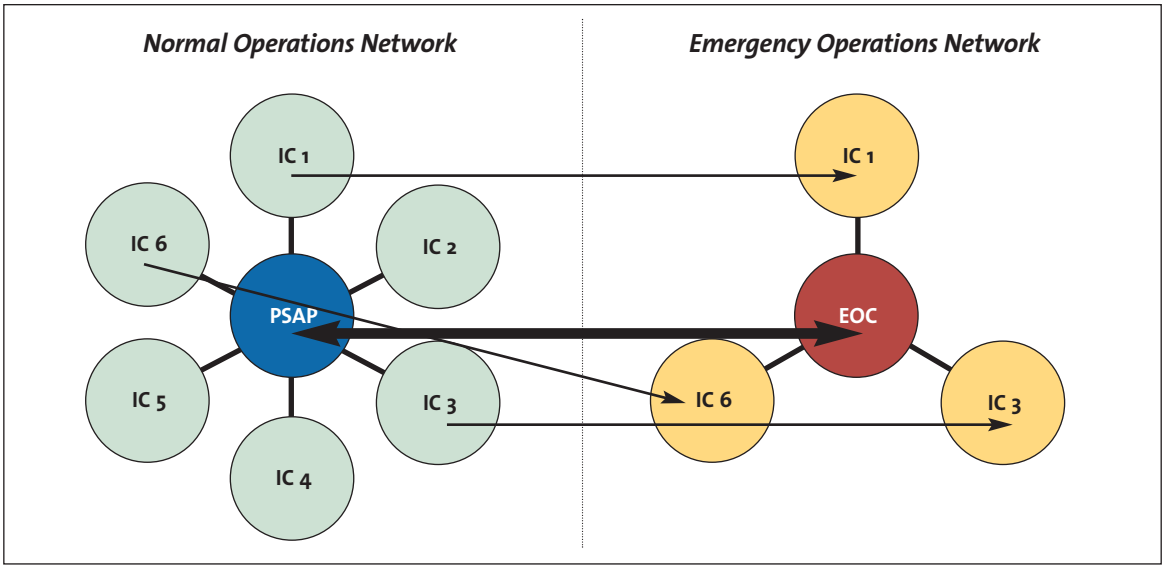
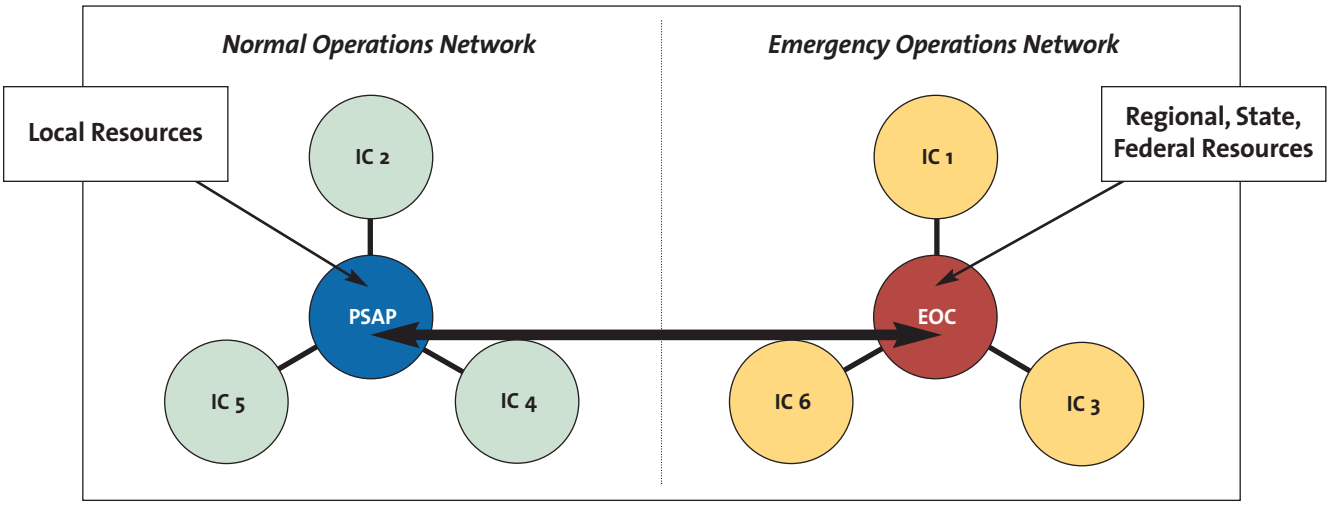


Figure 7: PSAP/EOC Coordination



Current Communications Systems and Operations

Land mobile radio (LMR) systems are the most commonly used commercial product for establishing and maintaining technical interoperability. This equipment is typically used as part of private radio communications systems owned and operated by separate emergency services. The discussion here is focused not only on LMR systems, but also on other commercial equipment and systems, outside the LMR environment. These can be used as an integral part of a technically interoperable system for information exchange. Although LMR equipment is not the primary focus of this section, the ability of other commercial systems to supplement, integrate with, or be connected to LMR systems is an essential component of technical interoperability.

It is practical and appropriate to assign as many support functions to secondary networks as possible.

Land Mobile Radio Operations

Emergency responders use LMR systems as the primary means of communications during emergency operations. Connections between LMR systems can be accomplished by sharing frequencies or channels, and by using interconnected systems such as the ACU-1000 or ICRI. These systems provide the technical connections between various LMR systems, such as VHF, UHF, 800 MHz, and cellular systems. Such systems can be used to patch together disparate radio systems on a temporary or ad hoc basis, depending on the needs of the event and the systems in use by response units.

During normal, day-to-day operations these systems should provide adequate capacity. However, when a major event occurs that requires the response of multiple jurisdictions or disciplines, these systems have consistently been proven to be inadequate. Typically, the LMR systems do not have the capacity—in terms of number of channels or frequencies—required for multiple jurisdictional or multiple disciplinary response operations. In addition, inadequate planning contributes to the overload and congestion that occur during such events.

Communications planning must include establishing a communications network structure designed and planned for multiple jurisdictional and multiple disciplinary operations. This structure must be consistent with the Incident Command System (ICS) or National Incident Management System (NIMS) structure, and must describe the functions, tasks or mission elements of a response. This includes the assigned communications network or system that is to be used by units and personnel assigned to each specific function, task or mission element. There are several ways that this goal can be accomplished, but the result is a table of functional assignments and corresponding communications networks (Figure 5), or the mission elements and corresponding communications systems (Figure 6) assigned for each element.

Whether communications planning involves functional or mission-related elements, it is practical and appropriate to assign as many support functions to secondary networks as possible. Assigning lesser priority traffic to alternative or supplemental systems prevents the primary operations and command networks from becoming overloaded; such overloading can block more urgent communications. Also, consider the availability and use of a secondary system of communications if the primary system becomes overloaded or disabled. The support systems can be pressed into service as the primary communications systems to sustain command, control and communications if the primary system becomes inoperative.

Commercial Communications Systems and Operations

Commercial solutions are available that can greatly enhance and improve operational and technical interoperability for public safety. Numerous studies have demonstrated that interoperability is not a matter of technology; but one of leadership and commitment. Commercial off-the-shelf equipment can improve technical interoperability quickly and inexpensively. Commercial systems have proven to be reliable methods for communicating voice and data information. They provide a relatively inexpensive and immediately available solution. Many fire departments would not be able to achieve interoperable data communications for many years without the benefit of affordable commercial wireless solutions. For successful implementation, specific capabilities and requirements must be clearly identified. For example, specifications for a cellular phone service may include the requirement that the system not fail if the normal power system is rendered inoperable, and that the system provide service to at least 95% of the coverage area.

A number of commercial providers have realized the importance of public safety organizations for the services they provide for the public and as a commercial market. Although several commercial providers have made attempts to specialize part of their marketing and product development towards emergency services, none has been more successful at meeting the needs of

emergency services than Sprint together with Nextel. Nextel has directed extensive resources towards meeting the needs of public safety services and has supported public safety customers with products and solutions. The International Association of Fire Chiefs endorses Sprint Nextel as a secondary or parallel communications system for the fire service. It is for this reason that Nextel products and services are used extensively as examples of how commercial systems provide support for daily administrative operations as well as emergency response operations. That said, the use of commercial services is not intended to replace the primary mission-critical land mobile radio fire service systems. The following section consists of a brief description of commercial equipment or service, followed by a discussion of how the equipment or service can be applied in the context of fire and emergency services.

Interoperability must work for routine operations as well as extreme situations involving hundreds of emergency response personnel from different disciplines and jurisdictions.

Handsets

Cellular phone handsets are used extensively for administrative and support communications. Cellular service is dependant on the Public Switched Telephone Network (PSTN). This is the same network used by regular telephone services. Most cellular phone services provide extensive coverage in the major metropolitan and suburban markets. While several commercial providers offer a Push To Talk (PTT) capability, the capability of Nextel's radio communications network distinguishes its cellular services from other providers. Nextel service is a nationwide wireless voice and data system that uses an integrated Digitally Enhance Network (iDEN), which is separate from the PSTN. Consequently, when phone service may be congested (which is common during an emergency), the Nextel service is not affected.

The iDEN system is an 800 MHz digital radio communications system that can provide radio communications across the United States. This capability is built into every Nextel handset. In addition to allowing the ability to communicate with another individual user, the Group Radio feature provides for group communications (Nextel), priority communications (Priority Connect), a local off-network user-to-user capability (Talkaround), and the ability to monitor talk groups (Talk Group Scan). These features are similar to those available on most fire service radio systems.

To meet the needs of public safety, commercial vendors can provide intrinsically safe, ruggedized handsets that look more like a portable radio. These devices include accessories, such as remote speaker microphones and multi-bay charger units. What's more, these units consolidate functionality so that emergency personnel carry the fewest number of devices, require less training, and maximize the effective use of the handsets that they carry.

The Nextel PTT feature can be used to communicate with staff members or field units when you are out of range of your department's primary LMR system. It also connects when an incident causes overloads on the LMR or public phone systems. The Nextel radio system can be used in these circumstances as a redundant back-up system to the primary LMR, or can be used to supplement the LMR by offloading support and administrative communications.

Individuals from the fire command staff can communicate and exchange information with individuals from police, EMS, the emergency operations center and any other unit that is on the system. Members of neighboring fire departments that are not able to communicate easily using the department's radio system can use the Nextel radio system to communicate with units and responders from other jurisdictions. Through console integration, Nextel can be integrated into almost any fire service's primary system. Nextel allows units or commanders to provide direction and control while responding to an incident, or when units are waiting direction at staging or base areas.

When two neighboring fire departments have disparate radio systems, a link can be established using the different system/common frequency approach. However, this approach presents problems from an operational perspective. When dispatched to an event, units from one jurisdiction are required to switch from their normal operating channel to the shared channel. It may be necessary for units from a number of jurisdictions to switch from their normal operating channels to the shared channel to communicate. Units that have switched to the shared channel lose communication with other units responding to the incident and with their dispatch center. They can miss the initial size-up report from first arriving units, or miss tactical directions and other important information about the incident. The negative impact of this situation can be prevented by using the Nextel radio system to communicate with responding units to

coordinate location, incident information, or directions from command officers without requiring units to change from their department's operating frequency or channel. Both jurisdictions' units and alarm rooms must have both frequencies. Provide a tactical channel for operations and have the alarm room monitor all channels. Tactical units must operate on one channel. Training, SOP's, SOG's, communication models and working together will overcome any of these issues.

Group Talk is another valuable capability of the Nextel/iDEN system. This feature allows individual users to join pre-established talk groups so that all members receive one member's transmissions. The Talk Group capability closely resembles the way that LMR systems operate—when one person speaks, everyone hears the message. This feature has been used in volunteer fire departments to allow members who are responding from work or home to communicate with each other while responding to the station or incident. Officers and incident commanders can use the Talk Group feature to keep informed about the number of personnel responding to either the fire station or the scene, when those resources are expected to arrive, and their staffing level or operational capabilities.

Group Talk can also be used to improve interoperability between field commanders and the EOC, or between the EOC and regional, state and federal response resources. Incident commanders can exchange information with EOC staff regarding support services and operations, planning or logistical issues, or communicate with other disciplines using the Group Talk feature. For example, all of the logistics function of the EOC could

Figure 8: Communications Planning by Functional Elements

Function, Task, Assignment	800 MHz	VHF	UHF	OTHER
Operations				
Fire Attack	Channel A3			
Ventilation	Channel A4			
Search/Rescue	Channel A5			
Water Supply	Channel B			
Logistics				
Staging				Direct Connect: Support Talk Group
Rehab				Direct Connect: Support Talk Group
Food				Cellular
Scene Security				
Perimeter		Channel 4		
Traffic		Channel 5		

be on one talk group, while the planning function is assigned to a different talk group. If the EOC and incident commander need to exchange information about logistical issues, those communications would be assigned to the logistics net defined as Talk Group 1. If the EOC and incident commander need to exchange information about planning issues, those communications would be assigned to the planning net defined as Talk Group 2.

Any individual on the talk group can share communications between the incident commander and the EOC. For example, if the logistics officer needs to talk with the incident commander in the field, the communications center contacts the incident commander and requests that he or she contact logistics on Talk Group 1. If all members of the logistics section are on the talk group, they will all be able to hear the communications between the logistics section chief and the incident commander. In addition, communications involving support operations are transferred off of the primary LMR system to the Nextel talk group, thereby increasing the capacity of the LMR to handle emergency communications without becoming overloaded. Resource management is made more effective, situational awareness is increased, and firefighter safety is improved.

Strong top-down leadership is needed to achieve interoperability because responsibility and authority cross organizational and jurisdictional boundaries.

The Group Talk feature also has uses for large scale or significant events. For example, units responding to base or staging areas could be assigned to a talk group while waiting for a tactical assignment. Pre-determined talk groups facilitate common locations. When command officers request resources from the staging area, the request for resources could be made on the talk group, with information about where the units are to report, to whom, and on what frequency or channel. Units leaving the staging area would then switch over to another assigned frequency or channel for tactical operations. This type of planning allows for more effective resource management and a higher level of situational awareness by offloading support communications from the LMR system to the PTT system, and by getting all resources in the staging area onto one common communications net. Even if units are responding to the incident from numerous jurisdictions with different LMR systems, they can be assembled and organized in staging areas for rapid deployment to tactical assignment using the PTT system.

The Nextel system used by public safety services can be given priority access over other users. The priority of calls is determined by the FCC's classification guidelines. When a major incident occurs, there is the possibility of congestion on the Nextel system. Priority Connect allows public safety users to gain and maintain priority over other private and commercial users. Priority level is maintained for both users for the duration of the call.

Paging/Messaging

Emergency service organizations that use a one-way paging service to send messages to administrative staff, field units and special team members are limited. Messages can be sent only one way. A two-way exchange of information is critical to interoperability; one-way communication systems do not meet the functional need for the exchange of information required for technical interoperability.

Many cellular phone handsets are now capable of both one-way and two-way messaging. For example, the Emergin Messaging and Emergency Notification system provides a two-way messaging capability that allows users to receive, send, forward and reply to messages through Internet-ready phones. Messages can be exchanged with any other messaging-capable phone or any e-mail address. Although paging or messaging may not be able to exchange information as quickly or as extensively as voice communication, there are still many effective uses for these systems. Paging and messaging can dispatch volunteers and special team members, and act as a back-up system for radio dispatch. The two-way capability allows responding personnel to communicate with the dispatch center or incident commanders, even if they do not have a radio.

Compared to cellular phones, portable radios are expensive. In many cases, it is more cost-effective to issue volunteers a handset with PTT radio capability and two-way messaging capability. This functionality can be merged with computer-aided dispatch functions so that, after a dispatch message has been sent, members who have received the message can reply to the dispatch center that they are responding. The dispatch center can also notify members what talk group to use before their arrival at the scene or the talk group that is being used by the staging area. Special team members can respond in the same way so that the dispatch center or incident commander knows how many special team members are responding and when the special team can expect to be functional.

The ability to send and receive messages through a two-way system helps responding personnel be informed about incident events, and gives commanders a better idea of when resources

become available and how they can be deployed. In addition, the Emergin system has built-in accountability. A centralized log tracks and monitors all messages sent, delivered and acknowledged. This system provides a detailed record, as well as real-time notification, without the delays experienced with many other paging/messaging systems.

Console Integration

An integrated communications system has tremendous impact on command, control and communications. Many emergency response organizations integrate their systems with the ACU Interconnect Systems manufactured by JPS, a subsidiary of Raytheon. The ACU and ACU-T units are designed to connect several disparate communications systems into one interoperable system. Several LMR systems can be connected so that units on one system can communicate with units on another. The ACU-1000 can interconnect up to 24 systems, including fire service systems (LMR) and commercial PTT systems. The transportable version, the ACU-T, interconnects with up to six systems.

Another option is to integrate a commercial PTT system, some of which are essentially an 800 MHz trunked radio system, with any other private radio system. This allows the PTT system to function as part of a comprehensive communications system. The International Association of Fire Chiefs endorses integrating the Nextel system into fire service communications to provide a secondary or supplemental communication system that supports the primary LMR system. Integrating your fire service radio with a commercial system provides a cost-effective way to supplement communications and improve interoperability.

For example, if an incident commander wants to talk to a hazmat team member who happens to be at a conference in another state, the commander can connect and exchange information with that team member and any other member of the hazmat team who is listening on the PTT frequency or channel assigned to hazmat operations.

Support personnel or agencies that do not have LMR capability may well have Nextel or PTT capability. For example, the Red Cross or Salvation Army, who are often part of support services resources at major incidents, can be included in support operations through console integration so that they can exchange information with staging, base or rehab officers on the LMR support net. A potential benefit for console integration is when dispatch net is used for those users who do not have LMR equipment. Once dispatched through the integrated LMR/PTT system, users who have the PTT equipment can be directed to the talk group for response information. Since this talk group is connected to the LMR system, all members on the talk group and the LMR channel hear the transmission. The system operates as if all members on the PTT and LMR systems were actually on a single system.

Figure 9: Communications Planning by Mission Elements

Mission Element	Communications System
Command and Control	800 MHz
Operations	800 MHz
Logistics	Direct Connect
Admin/Finance	Cellular
Law Enforcement	VHF
Medical	UHF

Here is an example of how a typical interoperable communications system may break out. To link the systems you can integrate consoles or use a gateway system.

GPS Location and Tracking

Global positioning systems (GPS) are most commonly used as part of automatic vehicle location (AVL) systems connected with a computer-aided dispatch (CAD) system. However, the combination of these systems is expensive to install and maintain, so many public safety services do not have GPS capability. Yet GPS-enabled cellular phones are a relatively inexpensive way to obtain the benefits of a positioning and tracking system.

Commercial GPS systems, such as the positioning, tracking and navigation solutions provided by TeleNav and others, are an example of the benefits of accepting the 80% solution. One of the major concerns of commercial GPS systems is that the mapping database used for positioning, tracking and directing users is not reliable or complete enough to meet the needs of public safety. While dispatch databases must be extremely reliable and complete, GPS positioning and tracking systems do not. If a communications and dispatch center has no GPS capability, then the level of completeness of commercial GPS mapping databases, which are clearly better than 80%, is a substantial improvement over no GPS capability.

Communications gaps in many communities are so severe that departments cannot communicate with each other in the same city, among departments in neighboring jurisdictions, or among municipalities and state and federal agencies.

The ability to position and track resources contributes to a more effective use of resources. Commercial GPS information can be integrated into CAD systems and used as an AVL system. Whether the resources being tracked are volunteer personnel or engines and medical units, their position can be used to determine which units are closest to an incident. Usually, the closest station is dispatched to a call for service. But if the resources assigned to that station are not in the station at the time, then other resources may be able to reach the scene of the emergency sooner. Commercial-based GPS can provide the information necessary to determine which resources can reach the scene of an emergency quickest.

GPS information can also be used by incident commanders. Information about the location of resources can be used to determine how quickly resources will be available for tactical assignments, and whether more resources should be requested. In addition, the GPS can be used to locate units and other resources at the scene of an emergency. For example, if all units in the staging area have GPS-enabled phones, then the GPS tracking program will indicate which units are at the staging area. If units are assigned to geographical divisions, or even functional groups, their location at the incident can be tracked as part of a resource or personnel accountability system. The geographic location of command staff can also be tracked using GPS-enabled phones so that commanders know the exact location of division or group supervisors. The limitation of GPS systems is that, because they operate using satellites, units that are inside buildings or otherwise blocked from sending signals will not be visible.

GPS programs can also provide driving directions for responding units and personnel. One GPS programs, TeleNav, provides visual and audible directions. Routes are automatically calculated and recalculated if the responding unit misses a turn. This type of system can be used as a back-up to paper maps or in conjunction with paper mapping procedures. For example, the TeleNav program might be used to get units to the general area. Units would then switch over to the paper maps for exact directions into locations if they are not available on the TeleNav database. GPS coordinates provided by these applications may also be used to land medical transport helicopters. Rather than trying to direct a helicopter landing by cross streets, a GPS system provides specific latitude and longitude coordinates for any location; these coordinates can then be communicated to the transport helicopter crew.

GPS systems can also be used as a mobile asset management tool. ActSoft has developed an application that tracks the amount of time that units spend on tasks and the location of those resources while completing tasks. Using their handset, units can clock in and out of customized task lists that provide information on what tasks crews are involved with and how much time they are spending on those tasks. This type of system can provide productivity information that can be used to manage programs and services, and support budget requests. Fire and emergency service crews and individuals spend much, if not most, of their working time away from fixed facilities like fire stations. Fire crews are out of quarters for training, conducting inspections, participating in life safety education programs, and other special projects. Most fire departments have no system to determine how much time is spent on these activities. Part of the problem is that it takes so much time to enter the data required to sustain this kind of database. If units can enter data one time and in small segments over the course of an entire shift, they are

more likely to enter accurate data that can be used in program planning and budgeting.

Interoperability Directory

To make interoperability work, you need to know who to talk to. Communities need an up-to-date resource of public safety and other community organizations. Sprint together with Nextel provides a secure interoperability directory for emergency response services to quickly and easily contact people, organizations, agencies and other resources. The ability to quickly and easily obtain resources and information contributes to the overall effectiveness of emergency operations by decreasing the time and effort required to get resources into action. The ability to contact specialists who can provide detailed information and advice about an incident is invaluable for rapidly developing and implementing an effective action plan.

Evolutionary and transformational change in operational patterns may be required if emergency responders are to meet the needs and expectations of the public in the current context of public safety services.

Use an interoperability directory that provides voluntary sharing of information by governmental agencies, organizations and individuals. Restrict access to government agency and other authorized users. A good directory allows searches by name, department or other search criteria. Successful searches provide contact numbers for work, mobile phone, Nextel radio system code and e-mail.

The ability to contact people, agencies and organizations is critical when responding to a major incident that requires regional, state or federal resources and information. If they are not part of normal day-to-day operations, it is usually time-consuming and difficult to obtain contact information. Without an interoperability directory, dispatchers or support staff must search through databases or other directories that are often out of date. The interoperability directory stays up-to-date by making all users responsible for the information they choose to share.

Database Access/Look-up

Law enforcement organizations can access information stored on a remote database. These database look-up applications can access state and local criminal justice information, as well as the federal National Crime Information Center database. Officers can check for felony warrants and view images remotely from the field. In addition, data interoperability has been found to significantly reduce the volume of voice transmissions during emergency operations. The Capital Wireless Integrated Network (CapWIN) project has demonstrated how data interoperability allows for the exchange of information between responding units, command and communications centers, and thereby reduces channel congestion and the need for complex radio systems.

This area of technical interoperability has enormous potential for fire and emergency medical services, yet is vastly under-developed. Database look-up is another powerful tool to access information for incident action plans and special team operations, as well as for inspection and investigation purposes. Firefighters can use database lookup systems to access pre-fire plans, while paramedics can access prescription drug information. Fire inspectors and investigators can access occupancy information and the history of fire code violations from the field. Remote access facilitates the most effective and efficient use of operational and administrative resources.

Application software and hand-held hardware can provide fire and emergency medical services with remote access to key information databases. Fire and EMS organizations use information databases regularly. Field access to databases increases efficiency by reducing the number of times information must be entered into forms. Basic incident reporting is usually initiated in the field, and then repeated when units return to quarters, where they access the reporting database. Off-site access to these databases reduces redundancies and the potential for errors. For example, the time and effort required to complete incident and inspection reports can be reduced if personnel can complete these reports in the field without having to return to the station to use a computer that has access to the database. Remote access can be achieved through secure, reliable Internet access applications and relay systems. Software applications and the handsets that are necessary to establish field access are available through private and commercial cellular services. A broad range of applications are developing in this area, and represent another benefit to working with commercial vendors.

Patient Tracking

The ability to track patients transported from the scene of an emergency is not only important for emergency responders, but

also for hospitals, and particularly for family members of those transported. The Emergency Patient Tracking System (EPTS) developed by Sprint and its partners is an example of a comprehensive system that provides important information about patient care and location that can be exchanged between emergency responders and receiving hospitals, and shared, when appropriate, with family members.

Using a Nextel handset or PDA and barcode scanner attachment, emergency medical personnel can quickly enter patient information, triage, and medical assessment information. The system allows personnel to check the status of potential receiving hospitals to make sure they are not on a divert status, or otherwise unable to receive the patient. At the receiving facility, EPTS information can be used to track incoming casualties, prepare for treatment and speed admissions. On-scene commanders or the EOC can monitor this information. It can also be provided to a separate information center at the scene, the EOC, or the hospital to facilitate family inquiries or to make public information announcements.

Because triage systems are not frequently used, except for in mass casualty incidents, they can be confusing for response personnel. Yet when personnel use the EPTS on a regular basis as part of their normal operations, then the procedures used to triage and track patients is smooth. It is best to implement a Mass Casualty Incident (MCI) Plan that uses familiar equipment and normal procedures.

Emergency Response Teams

Even the best interoperable systems may not be able to support large mass casualty incidents or regional emergencies. Whenever a large scale emergency or event stresses your system, consider calling in an emergency response team (ERT). For example, the Nextel ERT responds to state and federally declared disasters, and can participate in field training exercises. The team is deployed with a range of equipment depending on the needs and requests of emergency response personnel. Nextel's ERT can provide equipment on short notice to meet the demand for communications systems and services generated by disasters. The team can field Satellite Cellular On Wheels (Sat-COW) units, Satellite Cellular On Light Truck (Sat-COLT) units, several hundred ruggedized handsets, and the managers and engineers required to place these units and associated equipment into operation and maintain their operation over the length of the disaster response and recovery phases.

Some jurisdictions have included these units into their emergency communications plans. Most emergency-management plans assume that disaster conditions may create significant damage to the communications infrastructure. The communications annex of the Federal Response Plan states: "At a time when the need for real-time electronically processed information is greatest, the capability to acquire it may be seriously restricted or nonexistent. In such situations, all surviving telecommunications assets of the various levels of government, augmented by extra-regional assets, will be needed immediately to ensure proper response to the needs of victims of the event." The Nextel ERT can be used as an extra-regional asset for restoring communications or supplementing primary systems that may have sustained severe damage.

The Sat-COLT and Sat-COW equipment allows emergency responders to establish communications systems in remote areas that normally do not have any communications system infrastructure, such as in the case of wildland fires. These systems communicate directly with satellites, so there is no need for local towers or other infrastructure. Deploying this equipment can create a local interoperable communications network where none would otherwise exist. The Sat-COLT and Sat-COW equipment can also be located in gaps between other systems or equipment, creating a larger interconnected communications network. Clearly, this is advantageous for emergency responders.

SOLUTIONS AND RECOMMENDATIONS: Establishing Interoperable Systems

Operational needs are the driving factor behind technical interoperability. Operational needs of response units must drive the type, level and extent of technical interoperability. The first step in developing a plan for improving interoperability is to describe the needs of emergency response resources. Who will work together? Under what circumstances will they work together? How will they work together? What information do they need to work together? How will information be exchanged?

Interoperable communication systems do not need to achieve 100% interoperability. Instead, they must achieve the level of operational and technical interoperability that is appropriate for the region. Involve the public in interoperability planning so that citizens and community groups are aware of the needs of emergency responders. Harness citizen support for decision making involving evaluating options and making recommendations for improvements. Interoperability planning that is done on a regional basis and that involves the public is more likely to receive the financial and political support required from local legislative decision makers.

Operational Interoperability Strategies

Even though every public safety service agency operates in cooperation and coordination with other jurisdictions and disciplines, these relationships are rarely planned or critically assessed from an operational perspective. Too often, operational interoperability is an ad-hoc relationship formed to respond to a single incident, and is dissolved after the incident is over. This operational model results in limited operational effectiveness and unnecessary risk for first responders. A coherent and shared description of current operational practices and capabilities provides the foundation for making changes in the way multiple jurisdictions and disciplines work together. Use this information during joint incidents and for planning improvements in joint operations.

Interoperability improves resource management and increases situational awareness.

An operational interoperability profile includes an assessment of the following:

- Incident Type: What types of incidents require a multiple jurisdictional or disciplinary response? How often do these types of incidents occur? What is their impact or the consequence of these types of incidents? The most frequent incidents or those that have the most severe consequences should be the priority for improving operational interoperability.
- Resources: What resources are required to effectively respond to high-priority incidents? Does the response require a multiple jurisdictional or disciplinary response, or both? Incident types that require the response of multiple jurisdictions or disciplines should be the priority for operational interoperability planning.
- Operational Options: Will the jurisdictions or disciplines responding to an event operate in an integrated or partitioned environment? In an integrated operation, multiple jurisdictions or disciplines are combined to accomplish specific tactical objectives. In a partitioned environment, jurisdictions and disciplines are kept separate and assigned different tactical objectives. If resources will be integrated into operations, this will require different command and control procedures and communications systems than if their tactical assignments are partitioned to a single jurisdiction or discipline.
- Operational Assignments: What are the anticipated assignments for the jurisdictions or disciplines that respond to the incident types? What tactical objectives and tasks will be assigned to them? Based on these assignments, what are the anticipated reporting relationships in terms of command and control within the ICS structure?
- Communications: What are the requirements for information exchange between response jurisdictions? Between response disciplines? Consider the type of information shared between command staff and operational units, between units, between command staff, and between support agencies.

•Prioritize these profiles based on the most critical types of responses that occur most regularly. Use the profile as a planning guide for response operations for critical incidents that do not occur frequently but that have severe regional or national consequences, such as a terrorist attack.

Regional/Joint Operations Approach

Interoperability is all about the ability of multiple jurisdictions or disciplines to operate together effectively. The ability to deliver effective emergency response services has become a much more complex endeavor. Effective response services require the cooperation of fire, police, medical and other agencies at a higher level than in the past. We cannot continue to operate in isolation from the other jurisdictions and disciplines that are essential to our ability to protect the infrastructure of our communities and the quality of life of our citizens. This is not a reflection of some kind of inability or lack of support or inadequacy on the part of emergency response organizations. It is the result of the economic, social and political conditions of our times. Whether we like it or not, whether we resist or cooperate, we are being forced to operate jointly with other jurisdictions and disciplines because it is what the public wants and expects. It is time to recognize this idea as a legitimate desire and need of the public, and to support the concept of joint operations between jurisdictions and disciplines.

The concept of interoperability planning must begin by examining the operational context of emergency services. What types of incidents require operational interoperability? Where do they occur? How often? What resources are needed from what jurisdictions or disciplines in order to effectively respond to these incidents? How will these jurisdictions/disciplines work together? Will operations be integrated or partitioned? What assignments will be given to which jurisdictions/disciplines? What information will they need? How often will information need to be exchanged? What systems will be used to exchange information? Are there back-up systems available in case these systems

become inoperative? Which systems need to be connected together into a system of systems that can provide the necessary information exchange? Do these systems need to be fixed or flexible in how and when they are linked?

Regional planning for operational interoperability provides the opportunity to gain the support of numerous public safety services for a plan to improve the operational capability of fire, law enforcement, emergency medical services and emergency management. These are important services for the public. When pubic safety services come together on a regional basis to support a plan for improving the effectiveness and efficiency of emergency response services, it is very difficult for any person or group to stand in opposition. The power of regional planning is in its ability to create and sustain the momentum of economic and political support necessary to develop, plan and implement changes in operational and technical interoperability.

Collaborative Planning

The ability to work together starts with the ability to plan together. Regional planning must involve the jurisdictions and disciplines expected to work together to provide effective emergency response services. Each jurisdiction and discipline involved must be open to the needs and desires of the others and include both line and staff personnel in the planning process. The approach to planning must be one of collaboration rather than competition. Each emergency service brings certain capabilities based on their mission, resources, training and equipment that can support other emergency services. Collaborating involves building on the strengths of each agency involved in the process so that the operational impact of emergency services is maximized. As has been stated earlier, any issues involving territorialism, competition and the myth of self-sufficiency do not belong as part of the planning process. As public safety professionals, whether paid or volunteer, we have a responsibility to rise above these issues for the good of the public and the safety of our people.

Unified Command and Control

Operational interoperability depends largely on the ability of jurisdictions and disciplines to effectively command and control resources operating jointly in the field. The ability of crews and personnel to work together in the field requires the support of command officers and depends on their ability to work together in a unified command structure. The planning process must include discussion of how command and control will work from a practical perspective. When units from other jurisdictions or disciplines are part of tactical operations, how will they be controlled and by whom? If there are limitations to their capabilities, what tactical assignments or objectives are appropriate based on their capabilities?

In addition, different jurisdictions and disciplines must agree on the command structure that will be adopted and used in joint operations. Several versions of the Incident Command System are currently in use around the country, while some jurisdictions use a very informal command and control system. The fire service uses the ICS system extensively, while law enforcement and emergency medical services are less familiar with the use of any formal procedures for command and control of resources. The National Incident Management System (NIMS) provides the foundation for the development of regional command and control systems.

The purpose of this system is to provide "a consistent nationwide template to enable Federal, State, local and tribal governments and the private-sector and non-governmental organizations to work together effectively and efficiently to prepare for, prevent, respond to, and recover from domestic incidents, regardless of cause, size, or complexity..." These concepts are consistent with the principles of operational interoperability.

The preface of the NIMS document goes on to state that "NIMS represents a core set of doctrine, concepts, principles, terminology, and organizational processes to enable effective, efficient, and collaborative incident management at all levels. It is not an operational incident management or resource allocation plan." NIMS is intended to provide the basic structure for unified command and control and still allow the operational flexibility necessary to accommodate local or regional needs. NIMS should be used as the framework for command and control, while the details of how this system is used should be determined by the jurisdictions and disciplines that will be working together though this system.

Technical Interoperability Strategies

The National Institute of Justice's "Guide to Radio Communications Interoperability Strategies and Products" is a comprehensive report on communications interoperability strategies. A summary of the information contained in that report is presented here; the reader is encouraged to read the entire report.

Four main strategies are generally recognized as options for developing technical communications interoperability. They are:

- Creating a single radio system that provides communication for multiple disciplines or jurisdictions.
- Establishing procedures for sharing a common frequency or channel between disciplines or jurisdictions.
- Installing a permanent gateway device that establishes a radio interface through communications centers.
- Deploying a temporary, transportable gateway or interconnect device that creates an ad-hoc interoperable communications system during a tactical operation.

Technical solutions are available to create interoperable communications. Select one that is affordable and expandable.

A single radio system can be established by swapping portable or mobile radios between disciplines or jurisdictions. A more expensive and long-range option is to create a shared communications system. A single system may involve combining dispatch and communications center, or simply linking them through a common CAD and radio communications system. Also, commercial services offer reliable communications system that can be used for non-critical communications or as an alternative or back-up to private LMR systems.

Using common frequencies or channels between different communications systems is another common strategy. One of the shortcomings of this strategy is the limited number of channels that are usually established as shared or interoperability channels.

System-to-system gateways are becoming a more common strategy for improving communications interoperability. These can be permanently installed in communications centers through a console patch to integrate different systems. For example, Console Integration equipment connects LMR systems with the Nextel Service. Portable switches or interconnect systems can also be used to integrate communications systems between resources in the field. The ACU-1000 and the portable ACU-T are probably the best known portable interconnect systems.

Communications or technical interoperability needs can also be evaluated based on the concept of a local area communications network and a wide area communications network. The frequency and number of incidents involving operational interoperability and the volume of information exchanged determines which jurisdictions or disciplines are included in the local or wide area network.

The local area communications network should include jurisdictions or disciplines with operational interoperability that you work with on a daily or weekly basis. These should have fixed technically interoperable systems that can support regular, frequent incidents requiring operational interoperability.

The wide area communications network includes jurisdictions and disciplines that operate together less frequently. Depending on the history of regional incidents and practices, include those that you work with once a month or less over the course of a year. Portable or flexible systems can connect one set of jurisdictions and disciplines for one incident, and another set of jurisdictions and disciplines for another incident. Clearly, it is not desirable, necessary or practical to include all possible jurisdictions or disciplines in the area wide communications network. Only agencies that would reasonably be expected to respond to an event should be considered.

Action Steps to Implement Interoperable Communications

Combine the talents and resources of the various public safety services in your area into your interoperability systems plan. The jurisdictions and disciplines involved in operations should collaborate in planning so that they can operate under a unified command and control structure.

Begin interoperability planning by examining the operational context of emergency services.

- What types of incidents require operational interoperability?
- Where do they occur?
- How often?
- What resources are needed from what jurisdictions or disciplines to effectively respond to these incidents?
- How will these jurisdictions or disciplines work together?
- Will operations be integrated or partitioned?
- What assignments will be given to which jurisdictions or disciplines?
- What information will they need? How often will information need to be exchanged?
- What systems will be used to exchange information?
- Are there back-up systems available if systems become inoperative?
- Which systems need to be connected to provide the necessary information exchange?
- Do these systems need to be fixed or flexible in how and when they are linked?

Each jurisdiction and discipline involved must be open to the needs and desires of the others. Include line and staff personnel in the planning process. Planning must be collaborative rather than competitive. Each emergency service brings certain capabilities based on their mission, resources, training and equipment that can support other emergency services. Collaborating builds on the strengths of each agency so that the operational impact of emergency services is maximized.

Steps to Create Regional Interoperability

1) Organization

i) Establish a regional interoperability planning group including at a minimum: Fire, law enforcement, emergency medical services, and emergency management.

2) Define the Problem

i) Conduct an operational and technical interoperability profile for each agency involved in planning.

ii) Conduct come-as-you-are training exercises to demonstrate the capabilities and limitations of the current interoperability profile.

iii) Describe explicitly the issues that have limited interoperability in the past.

3) Establish Criteria for a Solution

i) Develop an interoperability planning matrix, including an assessment of the following issues:

(a) ICS and C3,

(b) resource management, situational awareness,

(c) individual communications systems,

(d) interoperability of individual communications systems.

4) Define and Describe Viable Options—Costs and Benefits

i) Operational practices

ii) Technical communications systems

(a) Improving current systems.

(b) Interoperability strategies.

(c) Commercial off-the-shelf equipment.

iii) Short-term and long-term options.

5) Recommendations

i) Describe regional context: political, social, economic, operational.

ii) Describe the factors that need to change to achieve an appropriate level of interoperability between jurisdictions and disciplines.

iii) Describe the short-term and long-term recommendations of the planning group.

iv) Explain the justification for the recommendations; the costs and benefits in terms of:

(a) Increased operational effectiveness.

(b) Improved personnel safety.

(c) Command and control.

(d) Resource management.

(e) Communications.

(f) Situational awareness.

(g) Ability to leverage assets.

(h) Faster planning and execution.

(i) Better decision making.

(j) Minimize ad-hoc workarounds and freelancing.

(k) More rapid, coherent, coordinated operations.

v) Provide a summary of the public safety service organizations and support service organizations that support the recommendations and why.

6) Implementation Plan

i) Short-term recommendations and goals.

(a) Action steps (what needs to be accomplished).

(b) Responsibilities (who is responsible).

(c) Costs (how much will it cost in terms of time, money, effort).

ii) Long-term recommendations and goals.

(a) Action steps (what needs to be accomplished).

(b) Responsibilities (who is responsible).

(c) Costs (how much will it cost in terms of time, money, effort).

iii) Support necessary to achieve short- and long-term recommendations and goals.

iv) Evaluation criteria used to monitor improvements in interoperability and impact on operational effectiveness and personnel safety.

Making Interoperability a Reality

Many improvements in interoperability can be made with shifts in resources, increasing the priority of interoperability, and training. Fire departments do not go to incidents without fire hoses, and police departments do not go without guns. Public safety organizations must place interoperability at the same level of importance as other essential components of their operational service capability. If we are without interoperability, we are limiting our operational effectiveness and placing our personnel at increased risk.

Multiple jurisdictional and disciplinary training exercises can be used to evaluate current levels of operational and technical interoperability. Come-as-you-are type training exercises will undoubtedly demonstrate that certain areas of interoperability need improvement. This is a good thing, and should not be perceived as demonstrating ineptness or incompetence. Joint training exercises identify interoperability weaknesses and shortfalls, as well as the obstacles to interoperability. Training exercises that demonstrate a need help to justify changes in practices and resource allocation. The challenge for public safety services is to be willing to show the real weaknesses in our capability to help justify necessary improvements in interoperability.

Commercial off-the-shelf technologies are potential solutions to interoperability problems.

Improvements in interoperability require strong leadership and a cooperative approach to regional planning. Because, by definition, interoperability involves multiple jurisdictions and disciplines, planning improvements in interoperability must involve the public safety and support services that work together on a regular basis. In addition, with the increased concern over homeland security, an even larger number of other public safety services and support services must be included in planning for a terrorist attack. Planning must recognize the need for interoperability to work in the day-to-day routing operations, as well as the extreme situations that occur infrequently, but have extreme consequences on a regional or national level. The challenge for public safety services is to get the appropriate representatives together to plan, implement, and evaluate interoperability improvements. Given the current context of public safety organizations, finding the time and resources for this effort may seem daunting. However, a combined and sustained effort on the part of public safety organizations to make improvements in interoperability is a powerful force.

Traditional land mobile radio systems alone are incapable of affordably providing the capacity, redundancy, and reliability necessary to meet the needs of interoperability. As interoperability increases, so must the complexity of operational procedures and technical systems. With an increased level of interoperability, the number of users exchanging voice and data information on a communications system will increase. The effort required to coordinate communications will become more complex as limited communications systems resources are allocated to more units or as different communications systems are connected together. Commercial off-the-shelf equipment and services should be used to improve interoperability and solve technical communications problems. Select commercial equipment, services and systems that have the capacity, reliability, and redundancy necessary to be used as a primary system of communications for administrative operations, and that can be used as a support system or supplemental communications system for emergency operations. The challenge for public safety services is to be comfortable using systems that we do not own or completely control. Ownership and control should not be a barrier to the improvements in our operational effectiveness and for the safety of our personnel that result from increased interoperability.

CASE STUDIES: Real-World Examples of Interoperable Communications

Charlottesville Fire Department

Developing Community Support

After Sept. 11, 2001, community leaders requested information on interoperability and development of a regional interoperable network. It is important to have a community leader who has access to and the respect of many constituencies.

Deputy Chief Charles Werner first met with other chiefs within his department, and then with other chiefs within other community agencies. The goal was to communicate the value of an interoperable communications system and then create awareness of the options and solutions. Once there was buy-in by various agencies, Werner migrated to working with the chief's designates in agencies such as city police, county police, volunteer rescue, community medical center, health department, schools, emergency services coordinator, poison control center, regional 911 PSAP, and others.

System Development

After determining needs, Werner set up the system. "We had outstanding support from the vendor to resolve functionality and provide training with phones. Demo phones in the right places also helped immensely. The vendor support was and is key to the success of such a program," said Werner

The fire department communicated with other community agencies as the system was deployed to be sure it was developed in a manner that could be shared. Successes were referenced from other locations and the value to emergency preparedness and interoperable communications was regularly conveyed. The fact that the Nextel walkie-talkies are not on the public telephone switch was important to various constituencies. The process took about a year to develop and implement within the fire service, and continues to be rolled out to various agencies.

Fire fighter Chris Carter checks his Nextel for updates.

The system is managed on a day-to-day basis by Werner and other fire fighters on staff who have shown an interest in technology.

Nextel Utilization

Sprint together with Nextel has provided an invaluable communications tool and helped Charlottesville overcome radio interference issues. It has also provided a redundancy (back-up to back-up). It has created unique and effective interoperability between other public safety agencies, across political jurisdictions and to critical non-public safety agencies (public works, schools, health and medical, transportation, etc.). It has fit within budget constraints, as it replaced existing wireless devices. It has also enhanced communication at special events (football games with 60,000+ in attendance, etc.).

"The system is working phenomenally. And it will be even greater when tied into our new radio system. I have never had such flexibility and effectiveness. While out of town, I have been able to communicate with various agencies, resolve problems, communicate to incident commanders and alert other city departments," said Werner.

The system has enhanced the department's ability to clearly understand voice communications and to do remote paging with units.

Charlottesville Provides Interagency/ Interdisciplinary Communications

Charlottesville is creating an 800 MHz trunked P25 public safety radio system that will achieve 100% interoperability between all public safety agencies within the region (fire, EMS, law enforcement, jail, airport, etc.), which includes the city of Charlottesville, Albemarle County, and the University of Virginia (approximately 744 square miles).

Charlottesville has learned that its primary system may not be, and most likely is not, enough to handle the avalanche of communications that occur during an unusual or catastrophic event. This was demonstrated in other locales, such as during the Salt Lake City Olympics, the World Trade Center/Pentagon attacks, and the crash of the Space Shuttle. Therefore, Charlottesville has several layers within its communications system. "We link the Nextel walkie-talkie (push to talk) to our public radio systems creating a network that can work in parallel to our public safety primary system. In reality this enables us to use Nextel's iDEN 800 MHz radio infrastructure independently for logistical communications as well as interfaced with our public safety system. It is tied to several interoperability talk groups on the public safety 800 radio system," said Werner. The overarching benefits received from this public-private interface will allow Charlottesville to expand its interoperability efforts beyond public safety to other key organizations, such as public works, transit, transportation, health department, poison control centers, medical centers, mutual aid dispatch centers, and schools, without any real effort.

Charlottesville will be implementing voice-over IP with an 800 MHz radio system (costing about $15,000), which will allow personnel to communicate with anyone in the world who has an Internet connection. Charlottesville will be able to take advantage of specialists from anywhere in the world for future incidents that cannot be anticipated today.

To address interoperability demands further and to support efforts with outside agencies at the tactical level, Charlottesville is deploying four interoperability boxes (ACU 100s) in the field. Theses will also link back to the public safety radio system.

The last level includes situational awareness across disciplines through the use of WebEOC, a password-protected software application that is accessible via a Web browser and that allows agencies to see activities or requests placed on them as well as other agencies. WebEOC gives everyone a better view of the big picture. Charlottesville is also working with CAPWIN to link their operation.

"Where I see the key value to Nextel is in the development of 'systems' which combine the use of Nextel phones to interface with legacy radio systems and utilize applications that enhance our ability to communicate during events," said Werner.

Nextel Services

Radio, CAD text alerting (with Emergin), talk groups, group talk, Priority Access, two-way messaging to phones for administrative (replaces pager), Internet access for chief officers. Currently, testing GPS applications with Comet Tracker.

Charlottesville started with purchasing the simplest and most inexpensive phones. Now that they have proven their effectiveness, Charlottesville is migrating to the ruggedized phones and looking at modems.

Capital Expenditure

Expenses are comparable to other communication options that Charlottesville has used or investigated. "We feel we get more value due to the added capacity of the handsets," said Werner.

The department's communication funding comes primarily from the city budget. However, the department received a $6 million grant from the U.S. Department of Homeland Security, of which part will be used to implement an interface with a new 800 MHz radio system.

Product Information

The department researched its communication strategies through active participation in various committees supporting interoperability. This allowed for networking and information gathering. Working with vendors was key to awareness as well as accessing information and facilitating successful demonstrations.

Next Steps

- Interface with CAD to automate notification to units, groups (using Emergin).
- GPS application to track fire units while in the field (using Comet Tracker).
- Interface with new 800 MHz radio system (using ACT/TRP-1000).
- Implement interoperability directory.
- Develop a formalized interoperability communications strategy for the region.

Anaheim Fire Department

System Development

Uses TeleNav for GPS positioning. It helped during the California wild fires by showing exactly where their rigs were. It updates positions every two minutes. They don't interface it with their CAD system, as they don't think that's necessary. Perhaps police or other first responders who are not statically deployed and use a fluid system could use the system to choose the closest unit for a dispatch. They do have the system in place to use in a large-scale emergency such as an earthquake; in that case they will use it to keep track of resources and choose the closest team to handle certain types of calls.

Capital Expenditure

It was an inexpensive system to set up. Is programmed by Fire Department with help from TeleNav technical support. Is using the 5-meg system, which is a little more expensive but still reasonable at about $20/month. The system can be downsized to update every 5 to 15 minutes for a small savings.

Product Information

There are a number of mapping and tracking features being brought online that will allow for routing and mapping for the user. The system also has the ability to find a user's location from a second phone. This will allow for pinpoint locations of field resources to be accessed directly from a phone.

Nextel Utilization

Anaheim uses a private radio system for its primary radio communications, but uses Nextel extensively as a parallel system covering paging, radio, and talk groups, as well as GPS. For many departments, a support system this robust would require fire fighters to carry numerous gadgets in addition to their private radios. For Anaheim, though, it's just one—a Nextel wireless phone.

Anaheim Fire Department Battalion Chief Larry Waterhouse uses technology to track apparatus.

Next Steps

- Set up a stop analysis system to collect data on the daily activities of fire inspections and haz-mat specialist.
- Report when inspectors get to sites and how long the inspections take. This history for each type of inspection helps create reports on annual time spent on certain types of inspections. This information can then be used to better demonstrate the amount of time it takes to do mandated inspections and generate reports that are required by the state.

Clayton Fire Department

Communications Issues

The St. Louis County region has 64 fire protection districts that can respond to a single incident, if necessary. Information sharing between many disciplines from many jurisdictions is crucial. One component to supporting interoperable communications is sharing actual, secure data and real-time written text messages, using the Internet as the common platform. In most areas, victims from mass casualty incidents are transported by the quickest arriving ambulances to the closest hospital emergency rooms. While offering a potentially rapid response for smaller incidents, in multiple or mass casualty situations, transporting many (or all) critically injured victims to the closest hospital results in overburdened facilities, slower medical response times, less than optimal patient care, inaccurate patient lists, and incomplete public information.

System Development

The St. Louis Metropolitan Medical Response System has embarked on several initiatives to integrate systems to improve patient care. The programs seek to increase cooperation, as well as leverage technology for improved communications and collaboration between the region's first responders, hospitals, and all others responsible for incident management.

The SLMMRS team knew that information technology was the key to integrating many organizations, including more than 700 forms of local government in the region, into one effort, and to increasing the efficiency of their response to an event. In August 2002, with the leadership and cooperation of first responders, hospitals, and public service organizations, as well as assistance from several industry partners, SLMMRS implemented a regional emergency patient tracking system. The tracking system enables first responders to communicate vital health information throughout the entire care continuum, improving access to, and reliability of, critical data to speed response, transport, and treatment.

Capital Expenditure

The project received grants from the Department of Homeland Security's Urban Area Security Initiative and the Department of Health and Human Services' Health Resources and Services Administration.

Developing Community Support

To ensure user buy-in and technical connectivity, the system development and implementation team must consist of at least one representative from each community of interest, including individual first responder units, patient transporters and hospitals.

Fire Chief Mark Thorp shows Tom Ridge, former Department of Homeland Security Secretary, the C Communication System.

Nextel Utilization

The county uses Nextel's (I58sr rugged handset, AGPS chipset built-in, JAVA capability, IDEN Packet Data capability) and AirClic scanners while the city uses Symbol PDA's to wireless remote to laptop. Software was developed by Raytheon and AirClic.

How System is Working

"Hundreds of times faster than the old system," according to Chief Mark Thorp, Clayton Fire Department. "Can you imagine if we had this at 9/11?" St. Louis City uses a PDA to wireless remote to laptop configuration. This eases data entry but is cumbersome and expensive. Only two units are in the field at one time. The counties use the Nextel configuration, which is a lot less expensive, because most units already use Nextel for a parallel fire service communications tool. The Nextels aren't as user-friendly, but because they are so versatile, they can go out with most units.

The EPTS is much faster and provides more accountability than previous systems. EPTS allows for greater command and control. EPTS also assists regional planning and government responses. EPTS provides real-time information regarding the human toll of an incident and the type of injury or disease. Local, state, and national homeland security officials may use the data to determine trends. If a biologic event or chemical poisoning occurs, intelligence gathered from EPTS, and enhanced with GPS and GIS mapping, can track the path of injury, and identify others who may be at risk. Additionally, data and text messages are continuously available for review and analysis.

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THE 3 Cs

PHOTO SCOTT LAPRADE

By William Pessemier

How to manage command, control & communications for events large & small

Communications technology is an essential component of command and control. During relatively simple incidents, such as residential structure fires involving only one fire department, responders can usually establish and sustain effective command, control and communications. However, when operations become more complex, such as the response to the Oklahoma City bombing, the shootings at Columbine High School or the terrorist attacks of Sept. 11, command and control become problematic, and communications problems can develop. For example, radio channel congestion and communications system overload occur at almost all catastrophic incidents involving multiple jurisdictions and public-safety disciplines. Some events, usually natural disasters, can severely damage communications infrastructure by blowing down radio towers, cutting communications cables or shutting down power supplies. These problems have a negative effect on resource coordination, response times and situational awareness. *The bottom line:* Resources are wasted, and we see an increase in casualties and property damage.

The public is well aware of our need to improve our response to complex incidents involving multiple jurisdictions, multiple disciplines and multiple levels of government. Recent natural disasters brought all of this to light, and the public expects—demands—that we do better. But we cannot continue to throw technology at the problem. First, we need a better understanding of what command and control are all about, and how communications technology supports them. ▶

THE 3 Cs

THE ELEMENTS OF COMMAND

Three main elements contribute to establishing and sustaining command and control: people, structure and technology (see Figure 1, below).

FIGURE 1: Components of a Command & Control System

People—from company officers to incident commanders—are the incident managers, who manage resources through an organizational structure. People also use technology to communicate and to display information about the response. A *doctrine of command and control* is established when people choose strategies and principles during response operations. For example, if the fire, law enforcement, EMS and emergency management people in a region met and decided to use the National Incident Management System (NIMS) for incidents, and if they agreed to share their communications resources in a specific way, they will have established a regional doctrine for command and control. A mission-oriented doctrine simply means that organizing and coordinating an effective response operation is the primary focus of decision making, not jurisdictional boundaries or interdepartmental rivalries.

Organized responses to complex incidents must be based on a common *structure* or system that each responding agency can use and understand, such as the incident command system (ICS) or NIMS. These systems provide an integrated organizational structure for managing resources during complex incidents. A good organizational system also establishes the authority structure and communications channels necessary for effective incident management, so that responders know whom they report to and whom they should communicate with.

Technology is used for communications and for data collection and display. Effective communications systems must be redundant, meaning that more than one system should be available for voice and data communications. For example, some fire departments that have switched from a UHF or VHF system to an 800-MHz system have kept their VHF or UHF system active as a back up in case the 800 system goes down. Other departments use their commercial cellular systems, such as the Sprint/Nextel push-to-talk capability, as a back up to their private radio system.

It's important to protect communications equipment from anticipated infrastructure losses due to natural disasters, such as hurricanes and tornadoes, or direct attack by terrorists, who may use an improvised explosive device to destroy tower sites for the purpose of causing confusion among first responders. Protective actions may include isolating, hardening, monitoring and surveillance. Additional information on protecting your communications system can be found through the National Infrastructure Protection Center or the National Communications System Web sites.

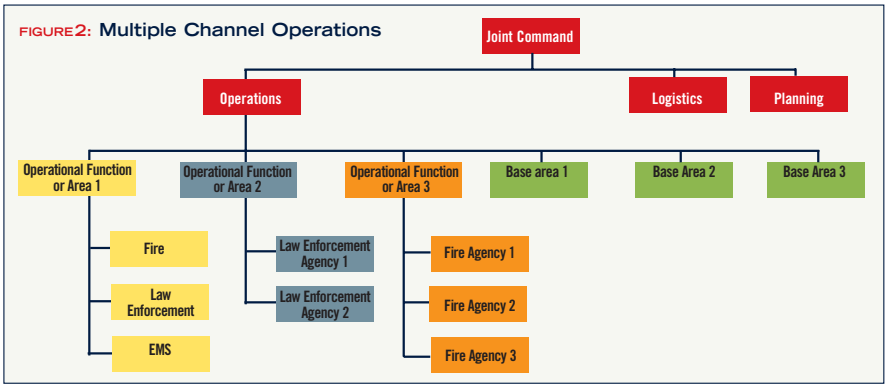
If protection systems fail, have contingency plans in place in the event the communications infrastructure gets blown down or blown up. If your technology becomes unusable, that does not mean your response is incapacitated. It simply means that you must rely more on the structure and people that make up your command and control system. For example, you may have to have to take people away from tactical operations to deliver messages that would have been delivered via radio or other technology.

CHANNEL DISTRIBUTION

An incident's communications channels should follow the incident's organizational structure. For example, complex incidents that involve joint operations between several jurisdictions and disciplines require a multiple-channel, multiple-systems approach to communications management. When large numbers of units and personnel are involved in an incident, we can't manage communications on one or two frequencies. When more than 20 people are trying to talk on the same channel, congestion will occur and critical messages will not be transmitted or will be transmitted too late. Therefore, organize communications resources into command, operations and logistics channels or systems. Figure 2 shows the communications structure for one command channel, three operations channels and a separate logistical system.

Organizing communications resources in this manner requires a different way of thinking about channel distribution. Most fire departments distribute channels by department rather than by function. Consider two departments that provide mutual or automatic aid on a regular basis as an example. One department might use two radio channels, while a neighboring department might use three different ones. Both departments probably have some type of commercial cellular service in use as well. Rather ▶

FIGURE 2: Multiple Channel Operations



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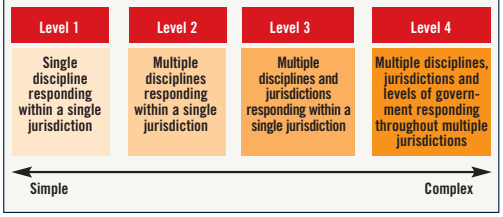
than distributing the five channels and two systems by department, the five radio channels should be organized into two command channels and three operations channels and shared between the departments. The commercial cellular system should be designated as the logistics system for all logistics-related communications. This minimizes the potential for channel congestion on the command and operations channels, since a large percentage of incident communications relates to logistics. Every department, from a small rural volunteer fire department to a major metropolitan department, can use their communications resources more effectively by distributing those resources by function rather than by jurisdiction.

This is very different from typical communications systems, which are often isolated and uncoordinated and use separate structures and systems for each agency. However, if different jurisdictions and disciplines are going to work together in an integrated, coordinated fashion, their communications must be integrated and coordinated as well. Get more information on how to develop regionally integrated communications systems and operations in the IAFC publication "Top Priority: A Fire Service Guide to Interoperable Communications," which can be downloaded at www.iafc.org.

CROSS-TRAINING

People are the most critical component of an effective command and control system. People use technology within an incident's organizational structure to direct resources, accomplish strategic objectives and deliver an effective, well-coordinated response, so it's important to train our people in multi-jurisdictional and multi-disciplinary response operations because they are much more dynamic, ambiguous and complicated than simple incident response operations. The complexity of a response increases as more jurisdictions, disciplines and levels of government are included in the response (Figure 3).

FIGURE 3: Level of Complexity in Emergency Response Operations



It is imperative that joint training between response agencies takes place so people have some experience working with other agencies and so they share a common understanding of the components of mission-oriented command and control. If this training and experience is not provided before a complex incident occurs, then it is unlikely the structure or technology employed as part of command and control can compensate for this deficiency, which will result in an ineffective and uncoordinated response.

Development of a mission-oriented doctrine of command and control must take place in the context of regional and joint operations. Relevant jurisdictions and disciplines should work together and outline how to structure complex incidents, how to integrate or connect technology for communications and data collection, and how people will train together in order to gain experience in joint operations. Mission-oriented command and control places mission accomplishment above everything else, especially the competition, turf wars and self-sufficiency that exist to some degree in all emergency response organizations.

KNOW YOUR THREATS

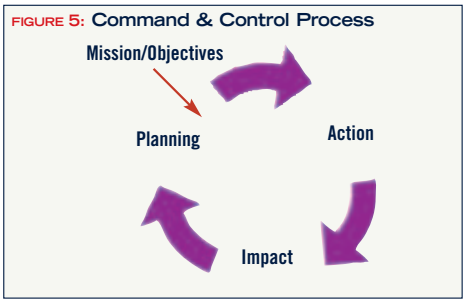
For an agency to determine its command and control requirements, it must first examine potential threat scenarios (Figure 4). After deciding on which threat scenarios to use, the agency must answer several questions: What is the anticipated impact of the threat? Will response operations require resources from other jurisdictions, disciplines and levels of government? What other agencies will be able to provide the necessary resources? Finally, what are the requirements in terms of structure, people and technology for an effective response?

COMMAND, CONTROL & COMMS: ON-SCENE APPLICATIONS

Applying a system of command and control involves planning, action and impact assessment, and communications is a critical element for each step in this process. The ability to plan for and establish a course of action is based on information about the incident, which is passed from operational units to incident commanders (ICs). The ICs use their situational awareness to develop the overall mission, strategic objectives and the incident action plan. They can then order resources into action to accomplish the mission and objectives. At appropriate intervals, these units report back to the ICs with an assessment of their progress. Based on this information, the ICs reassess their plan. This is a continuous cycle (see Figure 5), which recurs until there are no objectives left and the mission is accomplished.

FIGURE 4: Development of C2 Requirements

FIGURE 5: Command & Control Process



THE 3 Cs

They can then order resources into action to accomplish the mission and objectives.

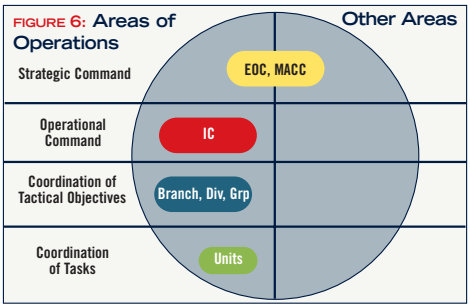


FIGURE 6: Areas of Operations

Additionally, operational units must have the ability to share and exchange information in order to coordinate their activities. This is true for all levels of command and control: strategic, operational, tactical and unit level (see Figure 6, Cedergardh 2002). Strategic-level workers must prioritize resources among operations, which may be geographic areas of operation or separate incidents. Operational-level command and control establishes the mission and strategic objectives for the incident and assigns units to the operation. Tactical-level workers coordinate units, which helps reduce conflict among different jurisdictions or disciplines. Unit commanders manage the performance of assigned tasks and report the impact of their actions to the next higher level of command and control.

CONCLUSION

Technology is a critical component of command and control, but without a good understanding of what command and control is really all about, technology is wasted. Effective use of communications technology results in a faster command and control cycle. The process of planning, action and impact-assessment occurs more rapidly and more effectively with high levels of technological support. High levels of technological support can overcome inadequate operational planning. However, high levels of planning and cooperation are the only thing that can overcome low levels of technological support. Anticipate and plan for complex incidents that will involve multiple jurisdictions, disciplines and levels of government. By planning for the use of a common command and control system, and making the best possible use of your communications technology, you will be able to get the right resources to the right place at the right time.

William Pessemier is the executive communications systems advisor for the International Association of Fire Chiefs and the author of "Top Priority: A Fire Service Guide to Interoperable Communications." Before retiring from a 25-year career in the fire service, Pessemier was the fire chief in Littleton, Colo., where he served as incident commander for the Columbine school shootings. He has a Master's degree in public administration from the University of Illinois and is currently working on a doctorate degree.

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